

$$1. (\lambda x. x x) ((\lambda x y. y x) z (\lambda x. x))$$

① normal order reduction

$$\begin{aligned} & (\lambda x. x x) ((\lambda x y. y x) z (\lambda x. x)) \\ \mapsto & ((\lambda x y. y x) z (\lambda x. x)) ((\lambda x y. y x) z (\lambda x. x)) \\ \mapsto & ((\lambda y. y z) (\lambda x. x)) ((\lambda x y. y x) z (\lambda x. x)) \\ \mapsto & ((\lambda x y. y x) z (\lambda x. x)) z \\ \mapsto & ((\lambda y. y z) (\lambda x. x)) z \\ \mapsto & (\lambda x. x z) z \\ \mapsto & z z \end{aligned}$$

② Applicative order reduction

$$\begin{aligned} & \lambda (x. x x) ((\lambda x y. y x) z (\lambda x. x)) \\ \mapsto & \lambda (x. x x) (\lambda x. z z) \\ \mapsto & (\lambda x. x z) (\lambda x. x z) \\ \mapsto & (\lambda x. x z) z \\ \mapsto & z z \end{aligned}$$

2.

① normal order reduction

$$\begin{aligned} & (\lambda x y z. x z) (\lambda z. z) ((\lambda y. y) (\lambda z. z)) x \\ \mapsto & (\lambda y z. (\lambda z. z) z) ((\lambda y. y) (\lambda z. z)) x \\ \mapsto & (\lambda y z. z) ((\lambda y. y) (\lambda z. z)) x \\ \mapsto & (\lambda z. z) x \\ \mapsto & x \end{aligned}$$

② Applicative order reduction

$$\begin{aligned} & (\lambda x y z. x z) (\lambda z. z) ((\lambda y. y) (\lambda z. z)) x \\ \mapsto & (\lambda x y z. x z) (\lambda z. z) ((\lambda z. z)) x \\ \mapsto & (\lambda y z_1. (\lambda z_2. z_2) z_1) ((\lambda z. z)) x \\ \mapsto & (\lambda y z_1. z_1) (\lambda z. z) x \\ \mapsto & (\lambda z_1. z_1) x \\ \mapsto & x \end{aligned}$$